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REPORT ON RESEARCH, EXPLOITATION AND ENRICHMENT PROCESSES FOR LEAD AND ZINC ORES SUITABLE FOR APPLICATION IN UNDERDEVELOPED COUNTRIES

By Ing. Marcello BILLI,
Dirigente dell'AMMI S.P.A.,
Rome

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REPORT ON RESEARCH, EXPLOITATION AND ENRICHMENT PROCESSES FOR LEAD AND ZINC ORES SUITABLE FOR APPLICATION IN UNDERDEVELOPED COUNTRIES

by Ing. Marcello Billi - Dirigente dell'AMMI - s.p.a. Roma.

Foreword

The problems connected with the research and possible exploitation and concentration of lead and zinc ores in underdeveloped countries, lacking roads, electrical energy and a sufficient industrial equipment, are substantially the same as those connected with the research and the exploitation of most metalliferous ores.

Research

Preliminary surveys

When ore bodies are not already known, the preliminary study of an unexplored region must be carried out by small groups composed of a mining expert, a practical geologist and prospectors with a good acquaintance of the area and its ores, and who possibly have already worked in research projects in territories and soils not very dissimilar from the geo-mineral point of view. Before starting to work on the ground, the experts should study and examine carefully all previous geological and mining surveys, if any, carried out in the area, and obtain all possible information on the positive or negative results of previous research projects.

Usually, lead and zinc bodies are found in geologically ancient formations, and the study of orogenetic phenomena with regard to igneous rocks should accompany the research of any vein outcropping or banks partially uncovered by superficial erosions. Geophysical research does not appear suitable for lead and zinc minerals. The application of such methods of research, experimented in Sardinia and in the areas of Iglesias and Bergamo, though only for the research of the continuity of already known mineral bodies, did not have encouraging results.

However, it will be for the technician who directs the project to judge in each single case whether or not to resort to this kind of survey. Useful information may be supplied sometimes by the geochemical exam of the soil and of underground waters. However, the teams who carry out these projects usually have all the instruments necessary for these particular kinds of research.

For the first phase of the survey, the teams should be supplied with self-supporting means of transportation, camping equipment, some equipment for chemical analyses (at least quantitative ones), mapping and sanitary equipment.

Explorative mining, training of personnel, and necessary equipment

When an ore body which makes it possible to presume a certain developmen has been discovered, the "opening" work will be undertaken. This work may be trusted at first to an expert supervisor, controlled from time to time by the experts of the research team. After a short training period, local labour may be used for this work. As the research goes further, more important mine works will become necessary, with the introduction of mechanical drilling and the performing of exploratory soundings. The local personnelwill be integrated with mechanics and sounding experts in each place where the research is being developed. Among the mechanical equipment needed, will be naphtha or gasoline compressors, according to the possibility of fuel supplies; automatic drilling hammers with the most important usual spare parts and equipped with drilling-bits; small drills with combustion or compressed air engines, with the necessary supply of rods, rims,

manoeuvre equipment, etc. The skilled personnel should also take care of the training of local elements who will take their place. National industry may provide the mechanical equipment.

Systematic control of research

The increased difficulties met with in the second phase require a continuous, timely, and systematic control of all elements gathered. Therefore, it will be necessary to have an expert geologist following the work, in order to orientate it in the best way, and a laboratory for rock analyses be always at his disposal. The chemical laboratory, besides, should be equipped for systematic quantitative anlyses to be carried out on the samples obtained from the mining.

Moreover, it will be necessary to build a warehouse to keep the consumable materials, the equipment and the spare parts, as well as a small mechanical shop for the necessary upkeep and repair work.

DEVELOPMENT

Limits of suitability for Development

When the presence of an ore body is ascertained, it is extremely important that the experts state whether it is opportune to extend the research with underground works which will require a much more complex organisation.

In the taking of this decision, it is necessary to take in consideration the price of lead and zinc (which do not have a very favourable trend) with regard to the high costs of a mining industry being organised in an underdeveloped area, with difficulties for transportation, subsidiary industries, unskilled personnel, etc. Nowadays, it should be said that, considering the present price of the mineral, the further development of mining should be limited only to those bodies having the features of a big mine (large amounts of ore having a sufficiently high grade to compete with the big, well mechanised mines of the countries which produce most lead and zinc minerals).

Organisation of the mine

When the ore body meets these requirements, it is possible to move on to study the organisation and the equipment necessary for the planning of the mine and for its outfitting for production.

After surface surveys and accurate geological studies have proved the presence of a sizeable and continuous mineralization, and small explorative soundings have examined its extension up to a certain depth, the ascertainment of the actual size of the mine should be the next phase.

This second phase, which should be undertaken only after evaluating the favourable perspectives for the starting of the mine, will require a complete "team" of mineral experts of all levels and specialized fields. Special care must be devoted to the instruction of local labour, in order to reduce as much as possible the expense deriving from the employment of specialized and qualified workers from other countries. It will be necessary to provide accommodation at the site of the mine for most of the personnel, with the essential sanitary and receptive accommodation, having regard to the healthiness of the area.

Generally, the planning and the preparation of the mine require the digging of vertical or inclined shafts and galleries with more or less difficulty according to the nature and size of the mineralized mass and of the surrounding rocks, the presence of gas, water, etc.

Shafts and galleries may be excavated by means of pneumatic telescopic hammers, with support, or with drilling sets, according to the circumstances. The loading of excavated material may be done automatically or by hand, when there is cheap local labour available.

National industry may easily supply the equipment and the materials necessary for the installation of any kind of electrical plant and for shops and laboratories. It may also supply any kind of mining material, for pneumatic drilling, extraction, excavation, loading, transportation, with both normal and mechanized "decauvilles", whether for long or short distances, etc.

The supply of mechanical means will gradually increase when, after the end of the phase of exploration, the development phase begins.

The choice of the underdeveloped country, should be the maximum production achievable, and therefore the lowest mining cost with regard to the shape and the nature of the mineral bodies and of the surrounding rocks. In the different cases of more or less thick vein bodies, of strata formations, the method usually adopted in Italy can be applied, and adjusted to the necessities of each single body.

For horizontal veins, the following methods can be adopted:

a) - upright horizontal slices with scrapers
b) - sublevel methods - sublevel caving
sublevel stoping
c) - warehouse methods
d) - mechized filling methods

In the case of arrays:

a) - block caving
b) - sublevel methods.

If the mineral body is near the surface, and the ration of the overburden and the useful mineral below does not exceed the limits of economic extraction, it will be possible to adopt the open pit and glory hole methods. In such cases, the excavation is completely mechanized and is carried out with extremely powerful drills, loading the material directly on the trucks, after blasting the rocks by means of powerful explosive charges. However, this is a very rare case in lead and zinc bodies.

In the case of the various methods indicated above for streams and veins or arrays, known mechanical equipment should be adopted, considering that, when the conditions of the body are such as to justify this decision, it is opportune to exploit mechanization as much as possible from the very beginning, considering, however, that the considerable decrease in the employment of labour must be parallel to a high degree of qualification of personnel.

Complementary Services

Since high amounts of power are necessary for drilling, extraction, ventilation, illumination, etc., and for the preparation of ore in a second phase, it is advisable to take care immediately of the building of a large electric plant sufficiently powerful, capable of increase when the recognition of the situation of the ore gives further elements to judge the power needed for the operation of the mine.

The unkeep of equipment and the building of new smaller parts, when there are no well-equipped mechanical shops available near the mine, should be provided by means of an electrical and mechanical shop with personnel suited for all the necessities of the mine.

The chemical laboratory should be further developed for the control of operations.

PREPARATION OF ORES

Preliminary Studies

The studies on the enrichment of the ore shall begin as early as possible on the material collected during the surveys, having the average characteristics of the whole body, before going on to exploitation, which may be conditioned by the possibility of usingall or only part of the ore according to its grade, structure, and washing properties.

Studies may be carried out at specialised centres, even far distant, on samples really representative of the rest of the ore body, considering the availability and nature of water, the convenience of different degrees of concentration with an eye to the eventual destination of the concentrated materials, both from the point of view of transportation and of metallurgical processing. In Italy, in the rest of Europe, and in America there are several specialized centres for such studies.

According to the structure and nature of the ores, it will be decided whether to adopt the easier enrichment methods (gravimetric, densimetric methods), as long as their output is acceptable, or simple or differential flotation, adapting well known schemes according to the peculiar characteristics of each ore.

The flotation of lead and zinc oxide minerals and of sulphur-oxide compounds require highly specialized personnel, not easily available even in the most industrialized regions. It is advisable if the size and the importance of the plant permit it, to extend automation of controls as far as possible in flotation plants, so that they may be removed as much as possible from theinfluence of personal evaluations, especially when the personnel employed is not fully skilled. For this purpose, automatic controls of the supply pulp and of the wastes are advisable, as well as controls of the alcalinity of the pulp and of its size, density, etc. There are on the market several kinds of equipment suitable for such purposes.

Water and energy resources

We have mentioned how the availability of considerable quantities of water at the mine or nearby, is one of the essential factors for enrichment plants.

Also the nature of the water has an important influence on the flotation. In fact, flotation may be performed with sea water for lead and zinc sulphides while this is not possible for oxides.

When surface waters are not available, it will be necessary to start research for ground water right after the research and discovery of the ore body. This research may be performed by means of drilling or by geophysical methods. If the area is subjected to periodical rainfall, the possibility of building collecting basins must be examined. In any case, and especially in very hot regions, equipment must be provided for the recovery of muddy waters, in view of the losses caused by evaporation. In absolutely arid regions, it will be possible to take into consideration only those bodies which are extremely rich and contain ores of a structure allowing the recovery of compounds at a sufficiently high grade even if composed of more than one mineral form of lead or zinc. Modern metallurgy makes it possible, in fact, to treat such compounds with very good results; therefore, they might be produced, as long as the total price can stand the high transportation expenses.

Size of plants

The size of mine and enrichment plants should be determined with regard to the ore present in the ore body. It is well known that in the mining industry the size of the plants is an essential factor for the economy of the enterprise. This should be kept in mind most of all in areas where the general management difficulties are increased by the special conditions of an underdeveloped country.

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